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EFFECT OF CUT-AND-LEAVE AND CUT-AND-TOP CONTROL TREATMENTS ON WITHIN-TREE SOUTHERN PINE BEETLE POPULATIONS

By

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Abstract

Effects of the cut-and-leave and cut-and-top treatments on within-tree populations of the southern pine beetle were evaluated in seven active infestations in central Louisiana. Beetle populations were significantly reduced only in December by felling freshly attacked trees.

INTRODUCTION

In 1970, at the height of the most recent outbreak of the southern pine beetle (SPB) (Dendroctonus frontalis Zimmermann), the pest was found on more than half the region's pine land. Records show that 8.5 million cords and 2.5 million board feet of beetle-damaged pine timber were salvaged from 1960 through 1978. This timber has been valued at $200 million (Price and Doggett 1978). It was estimated that only one-third to one-half of the beetle-affected timber was salvaged. During this same period, State and Federal agencies spent over $12 million on SPB suppression programs.

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Currently, four suppression methods for SPB are recommended in various combinations: (1) salvage removal, (2) cut-and-spray, (3) pile-and-burn, and (4) cut-and-leave. A fifth method, cut-and-top, has had limited use in Texas. Salvage removal is the most widely used of these methods. Often inclement weather conditions, administrative delay of sales, low volumes of timber, inaccessibility of spots, or a poor timber market severely limit the effectiveness of the salvage-removal programs. During such times, the other suppression methods offer advantages.

Cut-and-spray and pile-and-burn, although still used sometimes, are potentially hazardous treatments. Because of the few acres sprayed each year, an environmental problem using lindane or chlorpyrifos (Dursban 4E®) has not been encountered. There are, however, potential risks associated with the formulation and application of these insecticides. In addition, these chemicals are costly to apply. Pile-and-burn must be restricted to times when the risk of forest fire is low. Air pollution could also be a problem in some areas. Clearly, we need alternative SPB control tactics that are both economical and potentially less harmful to the environment.

Two such tactics--cut-and-leave and cut-and-top--are relatively easy to apply. It has been shown that cut-and-leave reduces SPB population survival (Ollieu 1969), disrupts natural aggregation behavior (Gara 1967), promotes dispersal, and reduces subsequent tree mortality (Billings and Pase 1979). Agencies using the cut-and-leave method include the Texas Forest Service (Texas Forest Service 1975), the Virginia Division of Forestry and the Georgia, Mississippi, and Tennessee Forestry Commissions.

The cut-and-leave treatment involves felling all infested trees into an opening created by dead "black- and red-topped" trees. This usually results in a large pile of infested trees. When the crowns are left intact the inner bark (phloem) moisture is naturally dissipated through transpiration.

The cut-and-top procedure is applied in the same way as cut-and-leave, except that the tops are severed from the bole. Proponents of the procedure believe that removing the top in the winter prevents transpiration and thus maintains abnormally high moisture levels for developing broods.

In both of the above methods, all hardwoods in the treated area should also be cut to eliminate any shading effects on the felled pines. A buffer strip of green pines (equal in width to the height of infested trees) is cut in front of recently attacked trees to prevent futher attacks on adjacent trees (Coster and Johnson 1979). The disruption of the natural pheromone source apparently encourages beetles to disperse at a time when they may not be physiologically ready to do so (Hedden and Billings 1977).

The objectives of this evaluation were to determine if cut-and-leave and cut-and-top treatments effectively prevented spot growth and the establishment of new spots within a quarter-mile radius of treated spots. Information was also gathered on the cost of application and landowner opinions regarding the tactics.

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From 1975 to 1976, evaluations were conducted in Louisiana to determine the effect of the cut-and-leave and cut-and-top treatments on beetle numbers.

METHODS

The study areas were in the Catahoula and Evangeline Ranger Districts of the Kisatchie National Forest, located in Grant and Rapides Parishes, La. All trees were loblolly pines (Pinus taeda L.) and ranged in diameter from 13 to 48 cm. Treatments were started on November 1, 1975, and ended on September 10, 1976. Seven separate spots were located and treated. In all cases, the cut-and-leave and cut-and-top trees were felled and exposed to full sunlight. The standing untreated trees were shaded on all sides, and none of the residual vegetation was removed. Treated and untreated trees were located within the same spot.

The population sampling techniques and equipment used for taking the 100-cm^2 bark samples were similar to those reported by Coulson et al. (1975). The first set of bark samples was taken on the first treatment day from all the infested trees in that spot, and two sample disks (north and south) were collected at 1.4 m intervals along the infested bole. The cut-and-leave and cut-and-top trees were immediately cut after sampling and exposed to full sunlight. A second set of bark samples was taken just prior to beetle emergence. Two samples at each height were taken on each untreated tree, and four samples were taken from the cut-and-leave and cut-and-top trees. These samples were incubated in rearing cups for 30 days to collect emerging adults.

Total numbers of insects on each tree for each sample date were estimated by the topological mapping technique (Pulley et al. 1976). Two variables were analyzed--survival and numbers of offspring per attacking adult. A one-way analysis of variance was performed using the actual data to conduct a multiple range test on the treatment differences. A two-way analysis of variance was done for the survival data after a figure for missing data (cut-and-leave March 1976) was generated by means of regression analysis. The Duncan's Multiple Range Test was used to determine if pairs of plots were significantly different from each other.

RESULTS AND DISCUSSION

For trees with late brood stages (large larvae, pupae, callow adults), there were no significant differences ($P > 0.05$) among treatments, dates, and treatment by date interactions. Treatment means were variable throughout the year. Table 1 presents average beetle survival by treatment and date. Overall averages show that the two treatments reduced survival an additional 11 to 15 percent over survival in the untreated trees. However, survival in the untreated trees was greatest for only three of the five dates.

In cut-and-top trees, average beetle survival ranged from 8 percent in December 1975 to 46 percent in September 1976. The largest survival percentages reflect a majority of pupae and callow adults in the study trees as compared to other treatment months (December and August), when primarily larvae were present. Beetle survival in untreated trees in July (32 percent) was similar to the July results (34 percent) of Palmer and Coster (1978).

Palmer and Coster found July survival in cut-and-leave trees to be 17 percent compared to this evaluation's 18 percent. In this evaluation, cut-and-leave beetle survival ranged from 13 percent in December 1975 to 52 percent in September 1976. The high (Sept.) and low (Dec.) seasonal values in beetle survival were comparable to the findings of Hodges and Thatcher (1976). One year had elapsed between the Hodges and Thatcher investigation and this evaluation.

Cut-and-leave resulted in the lowest average survival for all seasons. Average survival was 24 percent for cut-and-leave, 28 percent for cut-and-top, and 39 percent for controls (table 1). This compares to the results of Hodges and Thatcher (1978), where survival was 32, 17, and 35 percent for untreated, cut-and-top, and cut-and-leave trees, respectively.

Instead of survival, the number of offspring per attacking adult was compared in the trees containing recent attacks. In this set of experiments, there were significant differences ($p < 0.05$) for treatments within treatment dates (table 2). There was no significant treatment-by-month interaction at the .05 level. This greater effect on early broods supports the findings of Ollieu (1969), but not those of Hodges and Thatcher (1976).

When compared to untreated pines, the numbers of offspring per attacking adult were significantly less for the cut-and-top and cut-and-leave treatments. Either lower egg production or higher brood mortality accounted for this difference. However, they were not different from each other. The December number of offspring per adult was significantly larger than the two June dates and the September date.

Table 1.--Survival (average) of southern pine beetle brood in standing, cut-and-leave and cut-and-top pines.

Treatment	DATE					Average
	Dec. '75	Mar. '76	July '76	Aug. '76	Sept. '76	
Untreated	0.20 ± 0.07[1]	0.76 ± 0.13	0.32 ± 0.11	0.34 ± 0.28	0.39 ± 0.23	0.39 ± 0.24
	(4)[2]	(3)	(3)	(3)	(5)	
Cut-and-top	0.08 ± 0.03	0.36 ± 0.10	0.38 ± 0.31	0.10 ± 0.01	0.46 ± 0.21	0.28 ± 0.22
	(4)	(3)	(3)	(3)	(4)	
Cut-and-leave	0.13 ± 0.10	0.18[3]	0.18 ± 0.04	0.18 ± 0.21	0.52 ± 0.30	0.24 ± 0.22
	(4)		(3)	(3)	(3)	
Average	0.14 ± 0.08	0.49 ± 0.25	0.29 ± 0.19	0.21 ± 0.21	0.44 ± 0.23	0.30 ± 0.23

[1] Standard deviation.

[2] Number of trees sampled.

[3] Missing datum estimated by regression analysis.

Table 2.--Average number of offspring per attacking adult from recently attacked pines.

Treatment	DATE				Average
	Dec. '75	15 June '76	29 June '76	Sept. '76	
Untreated	3.30 ± 1.10a[1,2]	0.45 ± 0.32	1.30 ± 0.40	3.70	1.90 ± 1.15a
	(3)[3]	(3)	(3)	(1)	
Cut-and-top	1.20 ± b	0.10 ± .04	0.90 ± 0.07	0.95 ± 0.35	0.70 ± 0.15b
	(1)	(3)	(3)	(2)	
Cut-and-leave	1.60 ± 1.10b	0.04 ± 0.02	0.90 ± 0.40	1.03 ± 0.49	0.90 ± 0.80b
	(3)	(3)	(3)	(3)	
Average	2.30 ± 1.10a	0.20 ± 0.26b	1.00 ± 0.50b	1.45 ± 1.11b	

[1] Mean and standard deviation.

[2] Means, followed by the same letter in each column, are not significantly different ($P < 0.05$).

[3] Number of trees sampled.

CONCLUSIONS

In this evaluation, cut-and-leave and cut-and-top treatments significantly reduced SPB populations only in limited situations. When freshly attacked trees were felled in the winter, the populations were adversely affected. It appears that microenvironmental changes have a greater opportunity to affect the beetle in these trees. Beetle survival is reduced by different amounts, depending on treatment and date of application; however, not all beetles are killed. It is not known how many beetles must be killed to prevent the breakout of a controlled spot. In the summer, controlled spots do not break out, and few new spots are initiated. This indicates that significant beetle mortality can probably be attributed to the dispersal phase (Billings and Pase 1979).

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